COURSE INFORMATION
PHYS 671: *Electromagnetic Theory II*

Course **Blackboard Learn** *website available* @ webcourses.niu.edu!

General Information

Location: LT 227
Time: Fall Semester of 2016, Tuesdays and Thursdays, 2:00 – 3:15 pm
Instructor: Dr. Bela Erdelyi
E-mail: berdelyi@niu.edu
Phone: (815) 753-6484
Office hours: after Tuesday class, 3:15 – 5:00pm in LT 225; or
contact me by email; or
set up an appointment
Duration: 15 weeks, i.e. 27 lectures + Midterm + Final
Credits: 3
Contact hours: 2.5
Laboratory: n/a;
Exams:
- *1 midterm*, during regular class – October 11, 2016
- *1 final*: comprehensive, emphasizing 2nd part – December 6, 2016 @ 2:00 – 3:50 pm in LT 227

Sources for Exams: the exams will be closed book/electronics. You may bring up to 4 pages (2 sheets, 4 sides) of helping material with you to the exams.
Grading: 40% homework + 25% midterm + 35% final
Letter Grades: an aggregate numerical value of at least 50% of the total points is required to pass the course with a C, with no component (homework, midterm, final) worse than 25%. The cutoff for an A grade will be approximately 85%, and lower grade level cutoffs every 5-10% (A-: 80%, B+: 75%, B: 70%, B-: 65%, C+: 60%, C: 50%, C-: 40%, D: 25%)
Homework Assignments: 4 sets (one set after each chapter), with clearly defined due dates/times. Late turn in of homework permissible only under unusual circumstances.
Course Expectations: read assigned material before lectures, attend the lectures, participate in discussions, read the appropriate sections of the textbook again after lectures, complete and turn in homework in a timely manner, solve as many problems as you can, take the exams. Expect to spend 6-9 hours per week outside classes on this course. You are encouraged to set up study groups, work together on problems, but the solutions turned in must be your own. Cite any material you used from publications, the web, etc. Homework turned in should be professional, clearly legible, showing all work, steps involved, derivations, etc. It is recommended to type up all homework solutions in Latex, Word, or Mathematica, etc.

Course Description

This course aims at providing a rigorous foundation for advanced classical electrodynamics and some of its applications. Particular focus is given to time-dependent phenomena stemming from the axiomatic definition of electrodynamics based on the microscopic Maxwell equations, and their consequences in vacuum and matter; and for source distributions and their associated fields and waves.
This is the second part of the course, with emphasis on charged particles, their dynamics and their radiation in a relativistic setting.
At the end of the course, students will understand charged particle and electromagnetic fields dynamics, interactions, physical phenomena arising in applications, and their mathematical treatment; and will have developed skills in problem solving utilizing, analyzing, and synthetizing these concepts.

Catalog description: Radiation from moving charges, relativistic formulation of electro-dynamics, collisions and scattering, multipole radiation, radiation damping and self forces.
Prerequisites: PHYS 670
Required textbook: J.D. Jackson, Classical Electrodynamics, 3^{rd} edition, Wiley, 1999, ISBN 0-471-30932-X. We will develop selected topics from Chapters 11-16, with a, hopefully, slightly more modern perspective.
Optional Readings. For a deeper understanding, you may also want to consult these:

J. Franklin, Classical Electromagnetism
L.D. Landau and E.M. Lifshitz, The Classical Theory of Fields
W. Panofsky and M. Philips, Classical Electricity and Magnetism

Syllabus

Chapter 1. Mathematics of Electrodynamics and PHYS670 Review

Lecture 1. Scalar, Vector and Tensor Fields, Vector Analysis, and Integral Identities
Lecture 2. Special Functions, Complex Notation, Fourier Transforms, and Delta Functions
Lecture 3. Maxwell Equations
Lecture 4. Waves, radiation, guides and cavities, diffraction and all that

Chapter 2. Special Theory of Relativity (Jackson Chapter 11)

Lecture 5. Introduction to STR, its principles and Lorentz transformations
Lecture 6. Kinematics in STR; momentum, energy, and forces
Lecture 7. Structure and mathematical properties of the theory
Lecture 8. Covariant representation and transformation of fields

Chapter 3. Dynamics of Particles and EM Fields (Jackson Chapter 12)

Lecture 9. Lagrangian formalism
Lecture 10. Hamiltonian formulation

Lecture 11. Canonical transformations, Symplecticity
Lecture 12. Examples of charged particle motion in EM fields
Lecture 13. Field Lagrangian, Hamiltonian, and interacting particles

Midterm.
Lecture 14. In-class homework solutions
Lecture 15. Exam
Lecture 16. In-class exam solutions

Chapter 4. Collisions, Energy Loss and Scattering of Charged Particles (Jackson Chapter 13)
Lecture 17. Energy loss in collisions (kinematics)
Lecture 18. Energy loss in Coulomb collisions (cross-section)
Lecture 19. Energy loss in Coulomb collisions (cutoffs, straggling)
Lecture 20. Multiple Coulomb Scattering
Lecture 21. Cherenkov radiation
Lecture 22. Transition radiation

Chapter 5. Radiation from Moving Charges (Jackson Chapter 14 and 15)
Lecture 23. Fields of a moving point charge
Lecture 24. Radiation of point charges in accelerated motion
Lecture 25. Bremsstrahlung
Lecture 26. Radiation damping

Chapter 6. Classical Models of Charged Particles (Jackson Chapter 16)
Lecture 27. Abraham-Lorentz self-force

Course Review
Lecture 28. In-class homework solutions
Lecture 29. Review for Final; Q&A

Accessibility Statement

Northern Illinois University is committed to providing an accessible educational environment in collaboration with the Disability Resource Center (DRC). Any student requiring an academic accommodation due to a disability should let his or her faculty member know as soon as possible. Students who need academic accommodations based on the impact of a disability will be encouraged to contact the DRC if they have not done so already. The DRC is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 (V) or drc@niu.edu.

Dated: June 7, 2016